Protocol for Controlling Groundwater Movement by Phytostabilization

Rafael E. Vazquez
AFCEE/ERS
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Topics

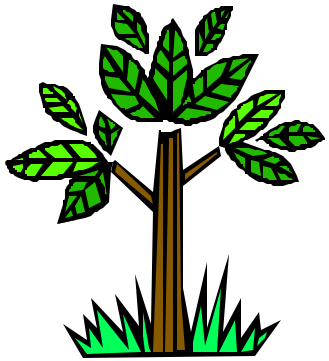
- What is Phytostabilization
- Benefits and Limitations
- Necessary Site Conditions
- Site Screening
- Implementation

Technology Definition

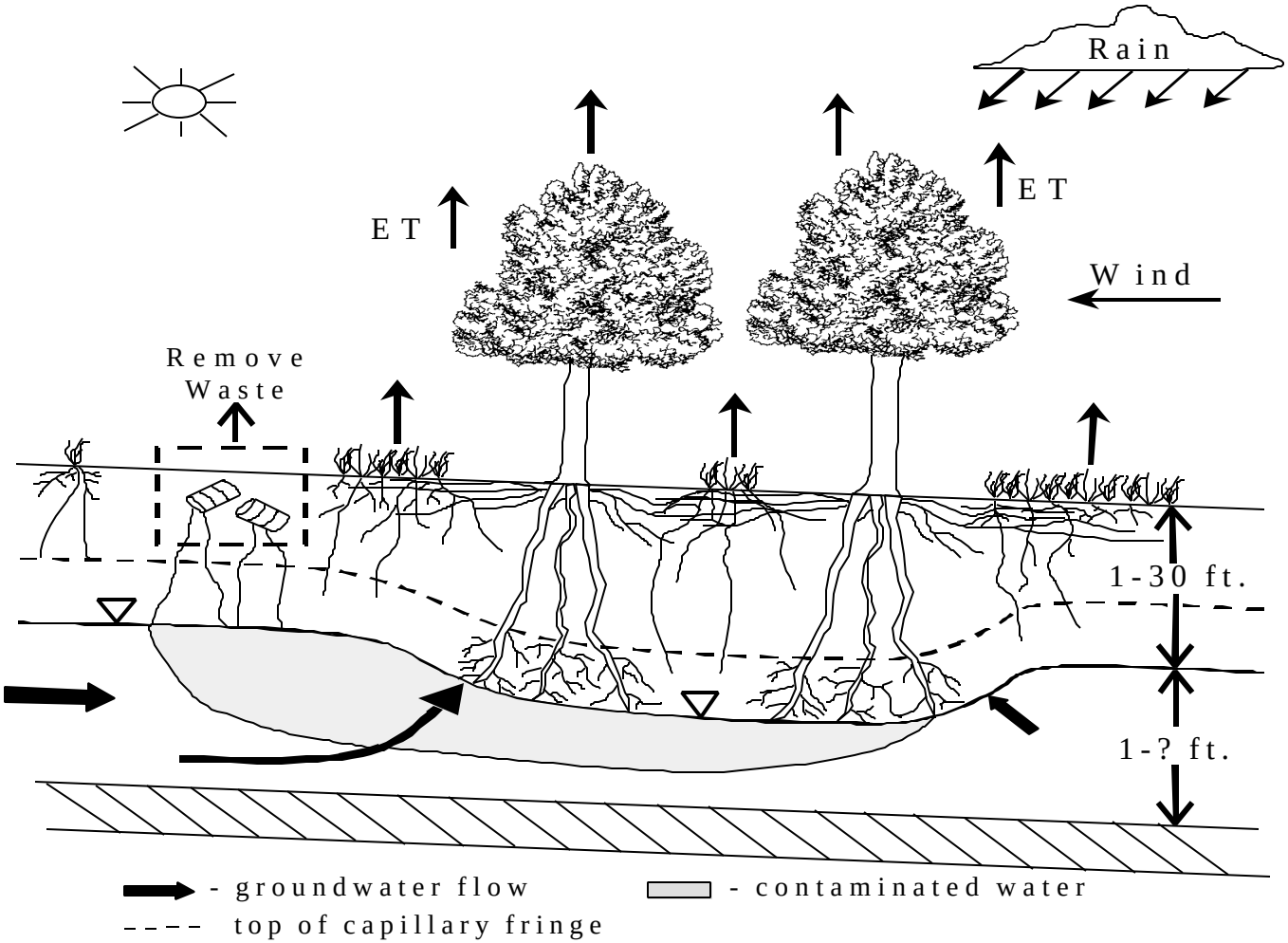
- **Phytostabilization or Phytohydraulics:**

  "…the use of plants to remove groundwater through uptake and consumption in order to contain or control the migration of contaminants."

  (USEPA, 2000)



Phytostabilization



Benefits and Limitations

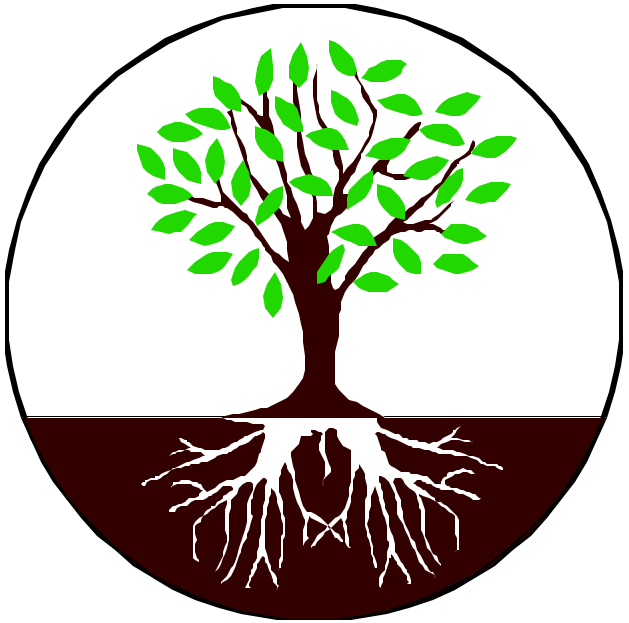
- **Benefits**
  - Minimal maintenance required
  - Low energy requirements
  - Aesthetically pleasing
  - Public acceptance

- **Limitations**
  - Requires large space for planting
  - Reduced water removal during dormant seasons
  - Potentially long start-up period
  - Height restrictions

Necessary Site Conditions

Requires suitable:

- **Climate**
- **Soils**
- **Hydrology**
- **Plant Selection**

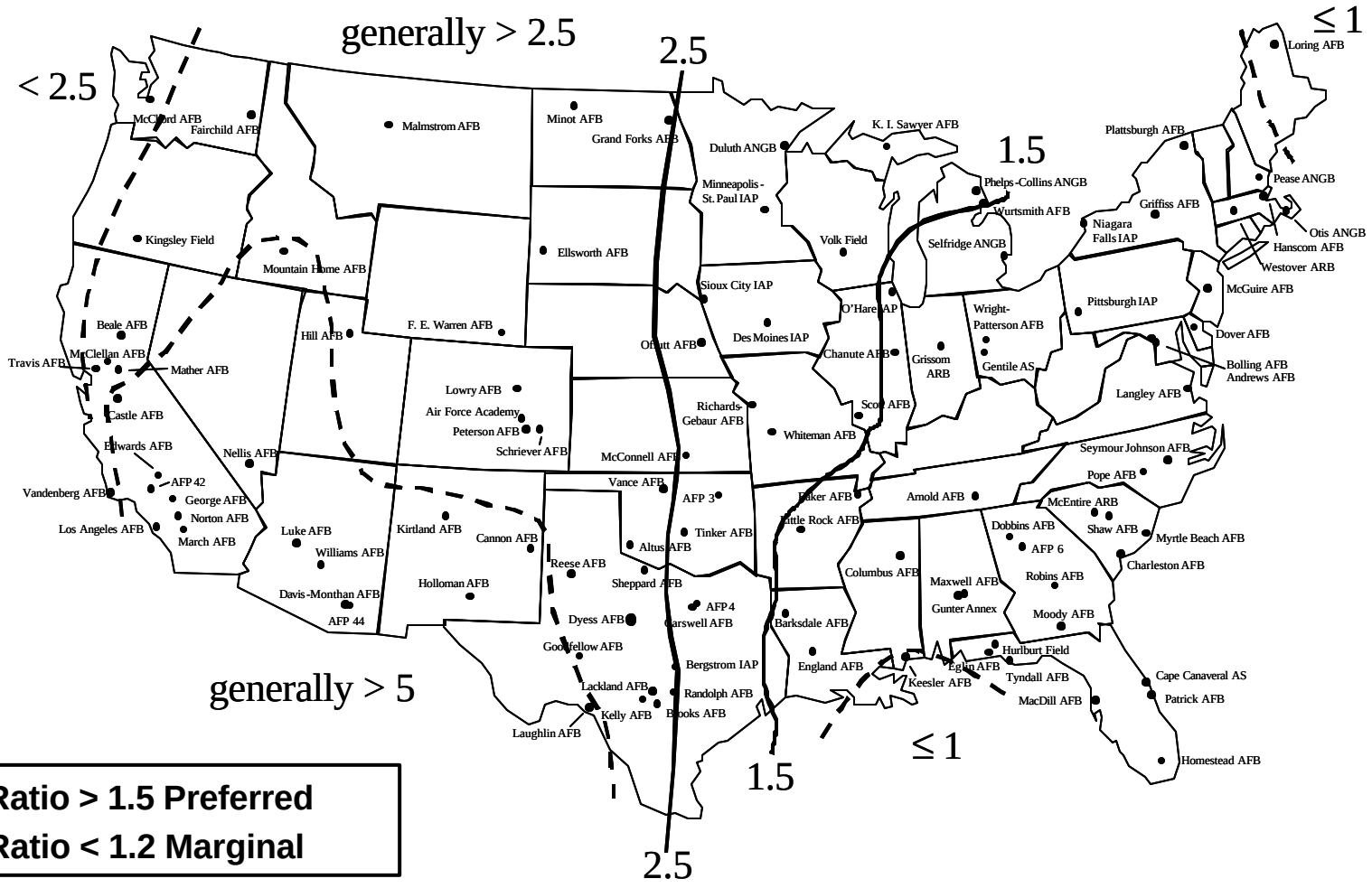


Evapotranspiration (ET)

- **Evapotranspiration *(ET)* is the evaporation of water from the soil surface and from plants (primarily through the leaves).**

- **Potential ET *(PET)* is the maximum ET that can result from a set of climatic conditions.**
  - **The amount of water that would return to the atmosphere if abundant, freely transpiring plant leaves are available and water supply is unrestricted.**

PET Ratio Map



- **PET Ratio > 1.5 Preferred**
- **PET Ratio < 1.2 Marginal**

Promoting Readiness through Environmental Stewardship

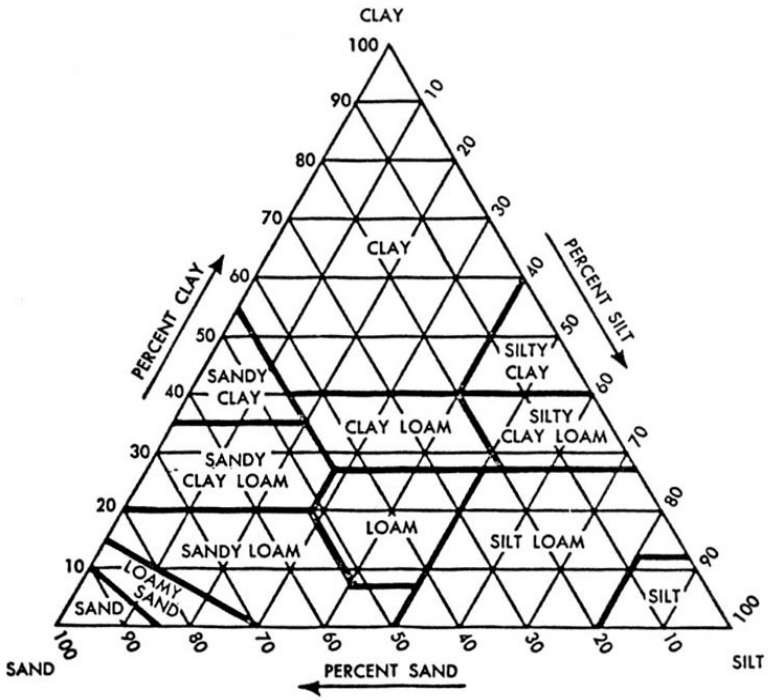
PET Ratio Values

- **The Protocol Document contains estimates of PET Ratio for 109 Air Force location in CONUS.**
- **Appendix A describes methods for estimating PET at other locations OCONUS.**
- **Vegetated Landfill Covers and Phytostabilization – The Potential for Evapotranspiration-Based Remediation at Air Force Bases – May 2001**

Soil Requirements

Preferred Soil Conditions:

- May grow best in a sandy loam soil
- Soil density less than 80 lb./cu.ft preferred
- No toxic chemicals



USDA Textural Classification of Soils

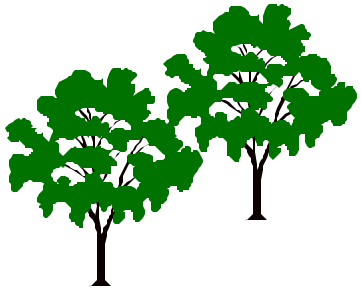
Hydrogeology

Phytostabilization requires:

- A shallow water table
- Moderate groundwater movement
- Separation from other aquifers
- Contaminants not toxic to plants

Plant Selection

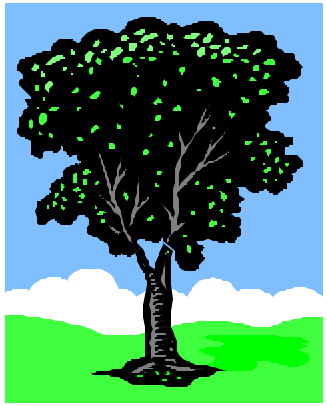
Criteria for Potentially Useful Plants:



- Perennials adapted to the site's climate
- Potentially use large amounts of groundwater
- Transpire water over a long growing season
- Grow rapidly to form large biomass
- Grow well in the presence of site contaminants

Plant Selection - continued

- **Trees**
  - Perennial plants
  - Have large root systems
  - May survive periods of adverse growing conditions

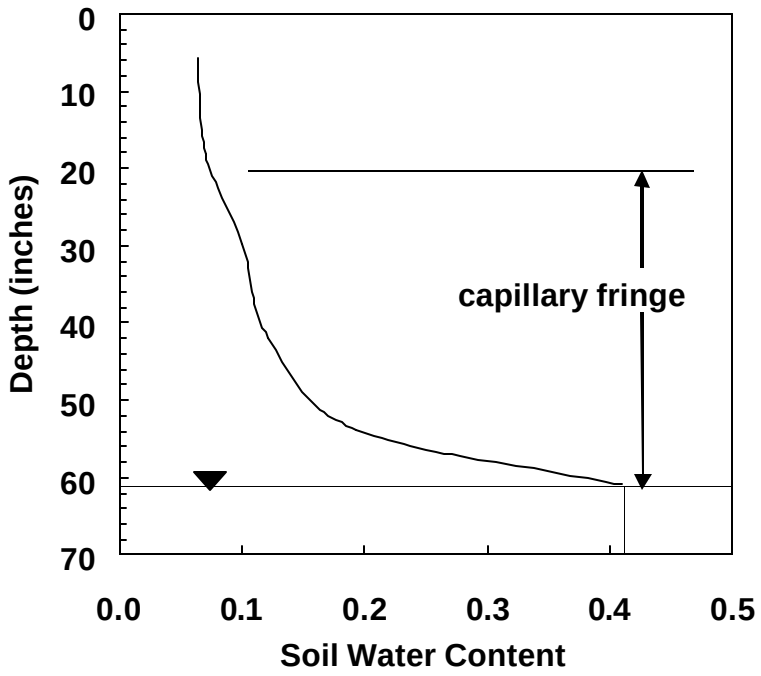


- **Grasses and Forage Crops**
  - Use in combination with trees as ground cover
  - May be used alone with a shallow water table

Plant Selection - concluded

Phreatophytes:

- Plants which use large amounts of water and acquire water from the water table or capillary fringe.
- Examples:
  - Poplar trees
  - Alfalfa

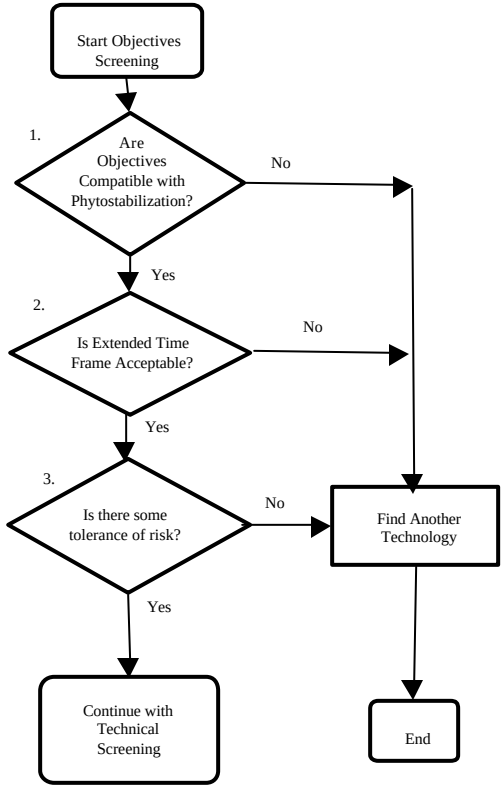


Site Screening

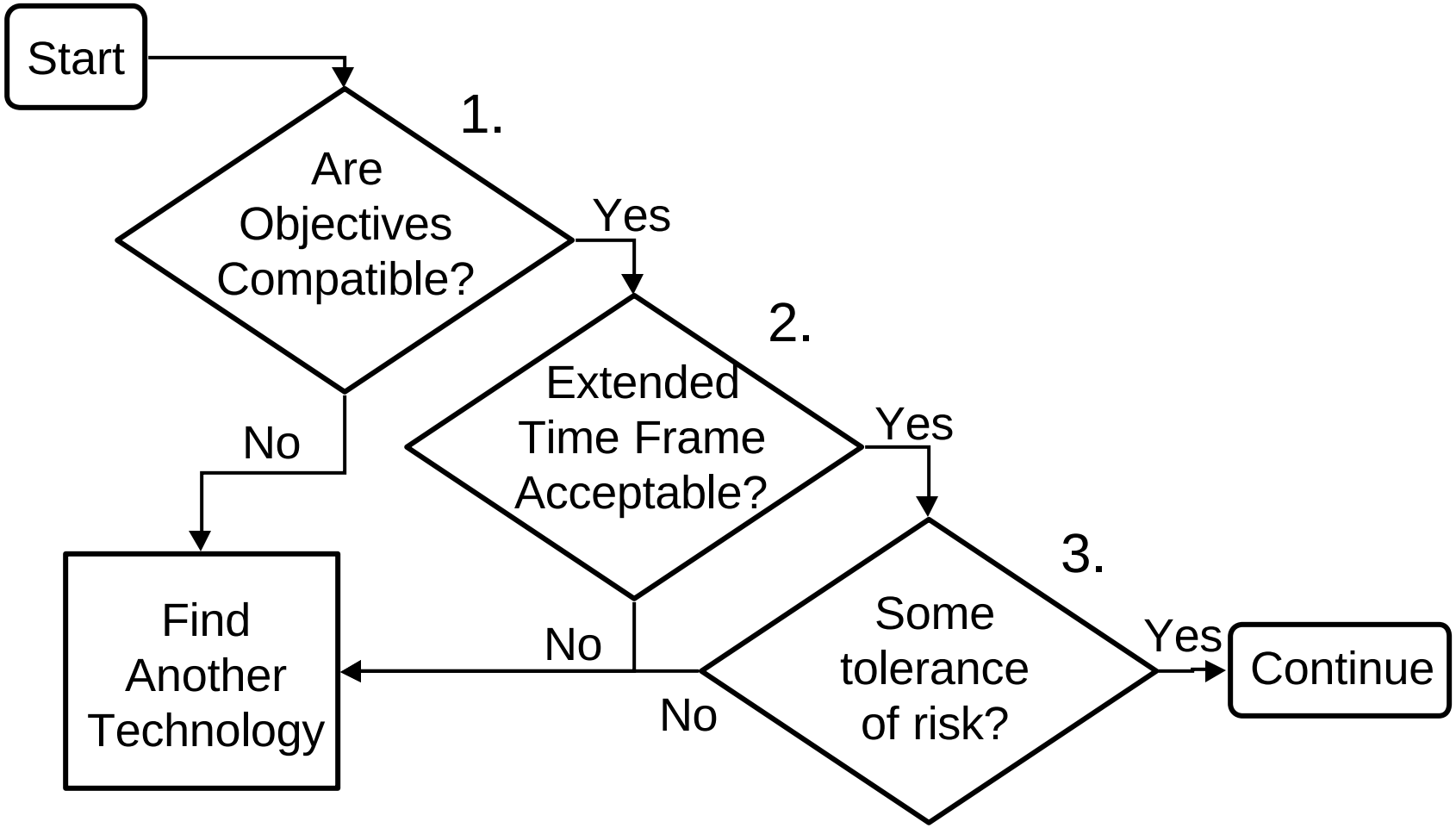
Will it work at my site?

Ten step screening process

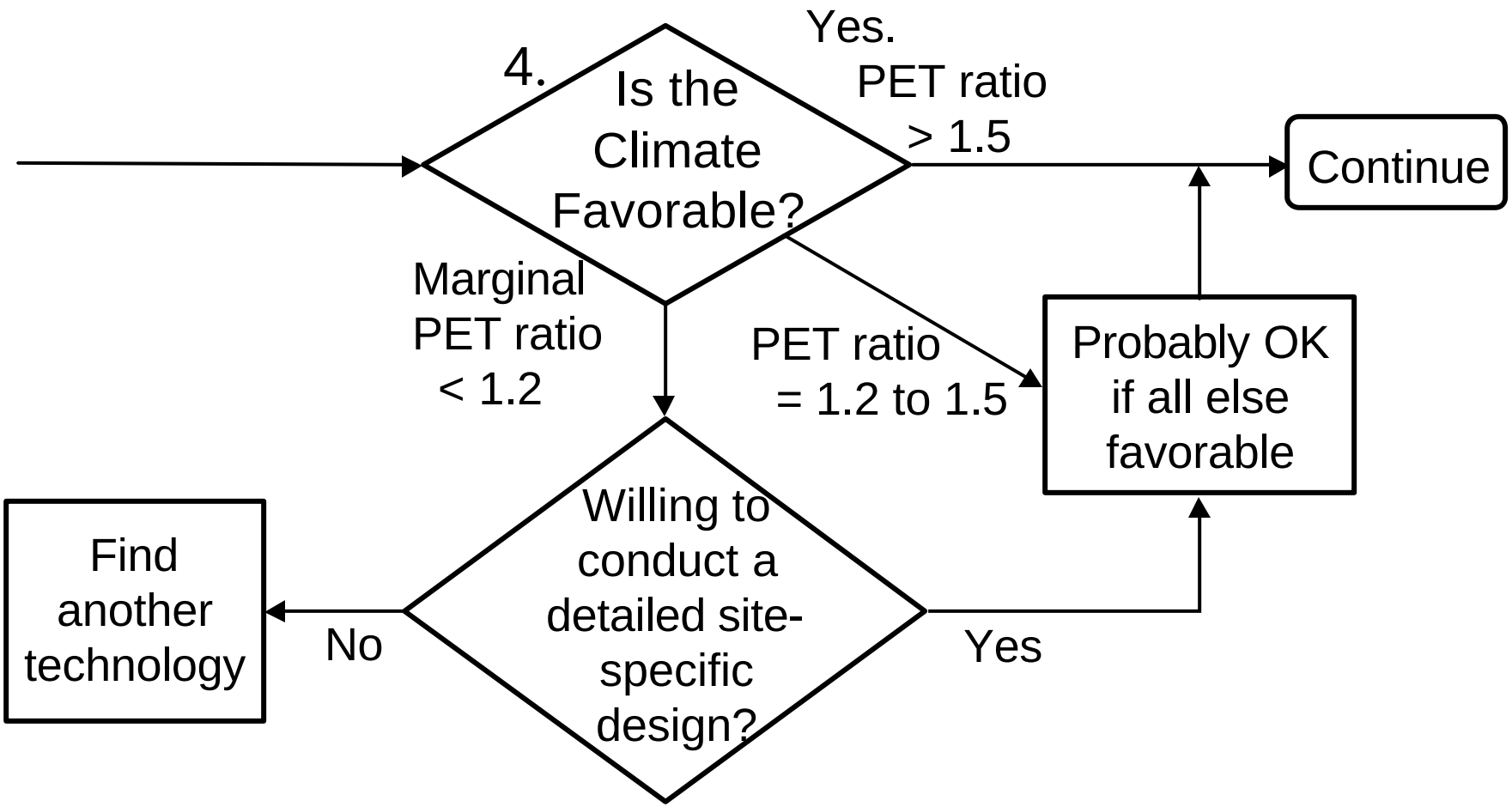
- **Objectives screening**
- **Technical screening**



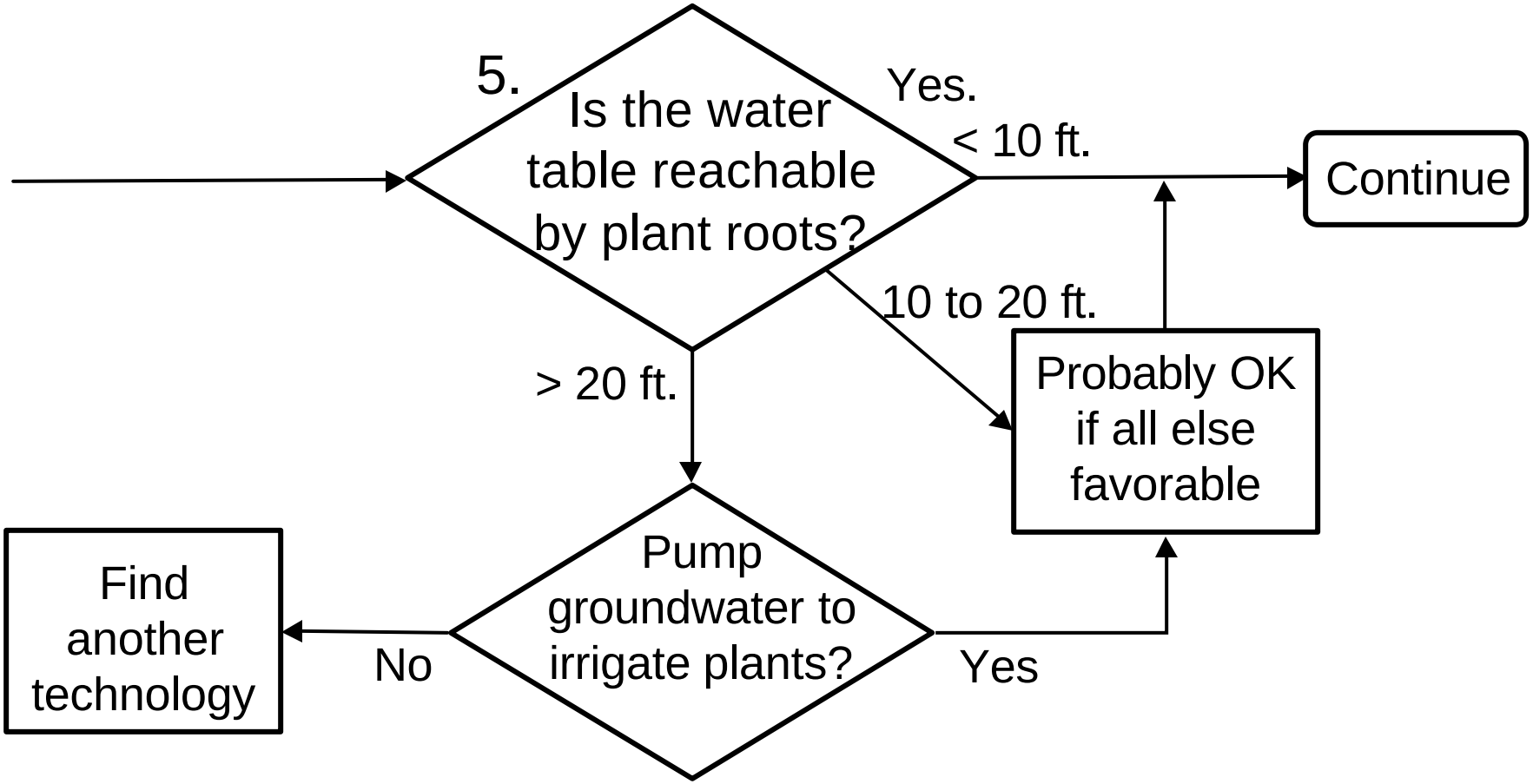
Objectives Screening



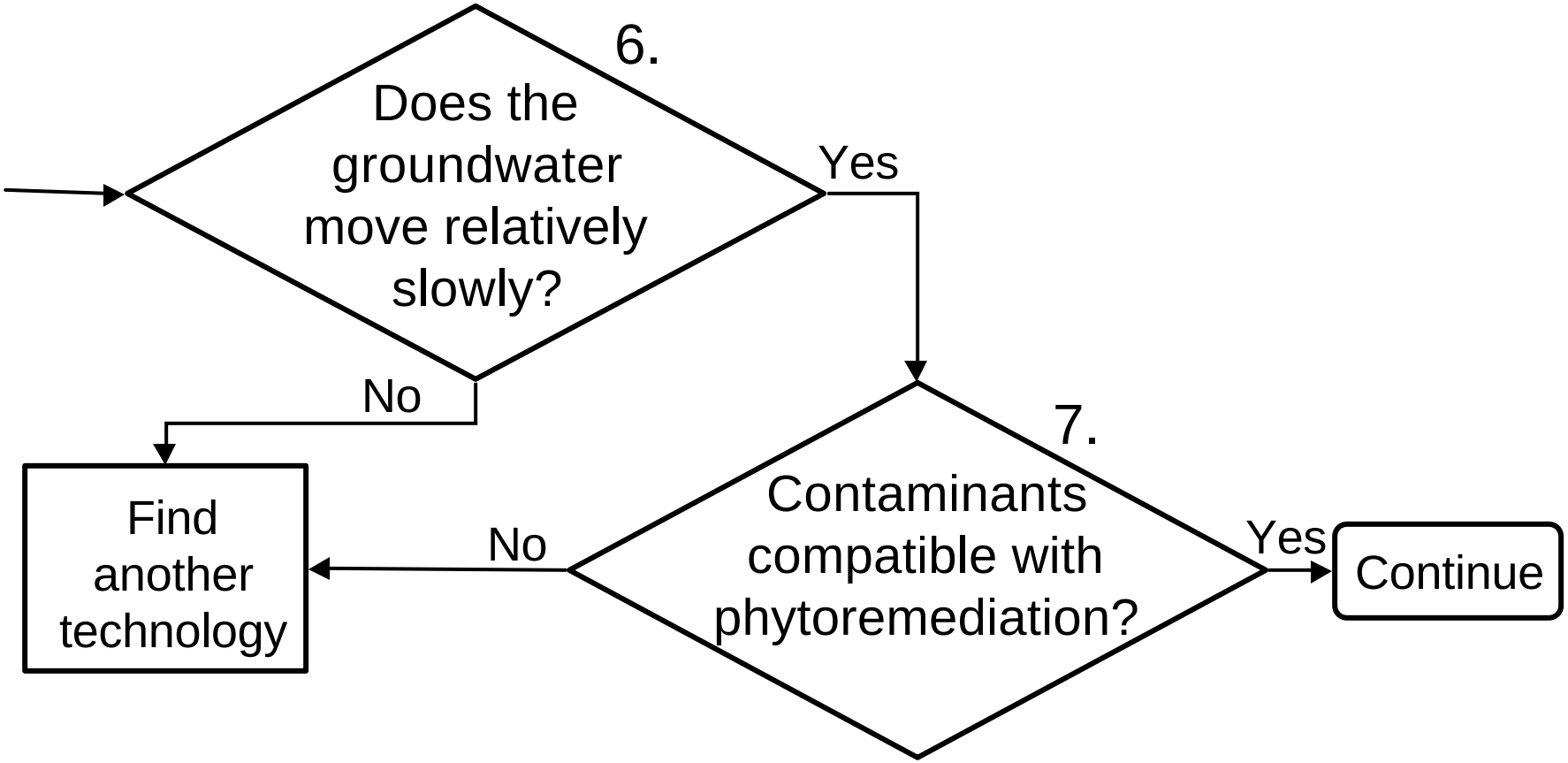
Technical Screening



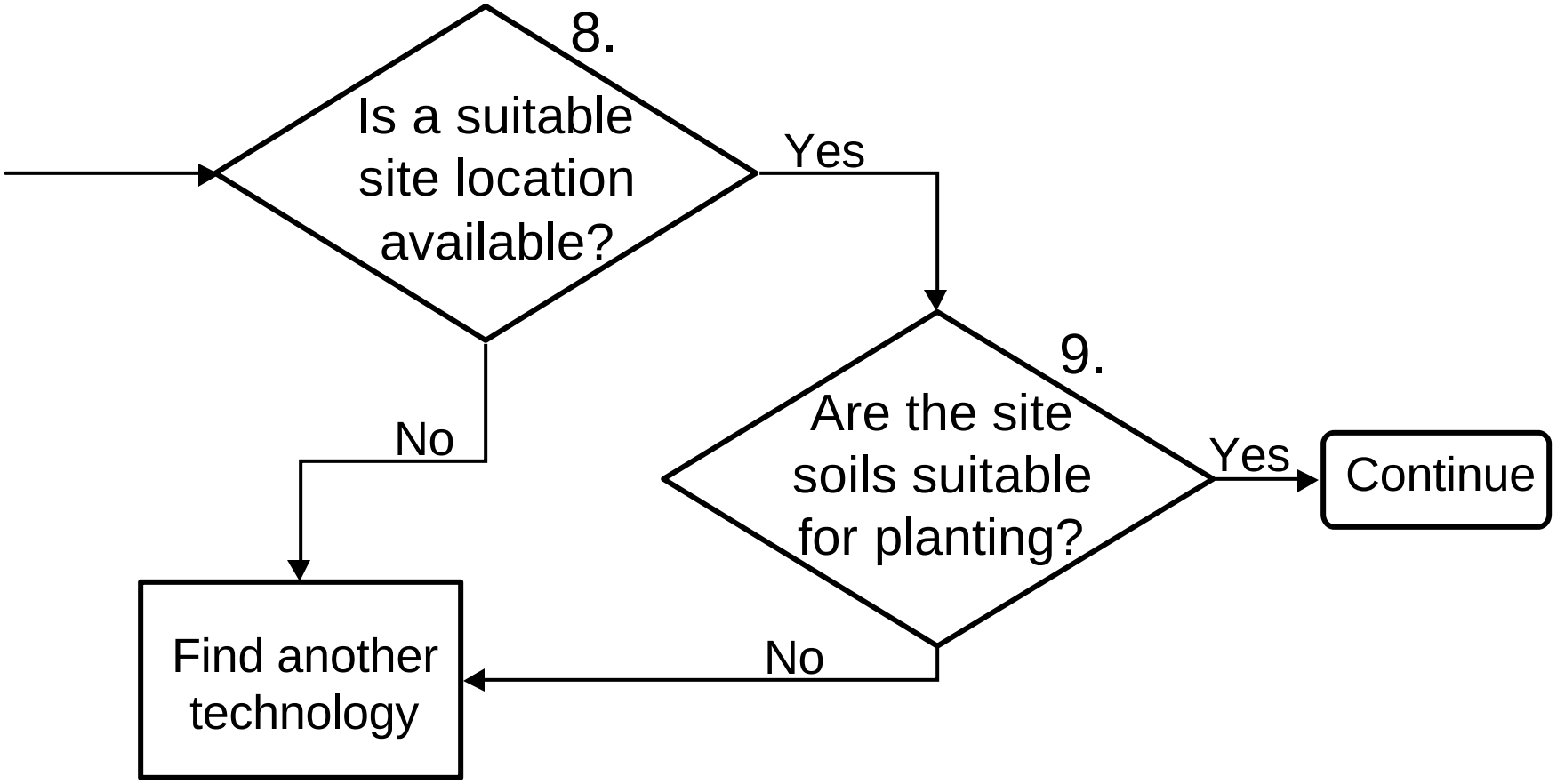
Technical Screening - continued



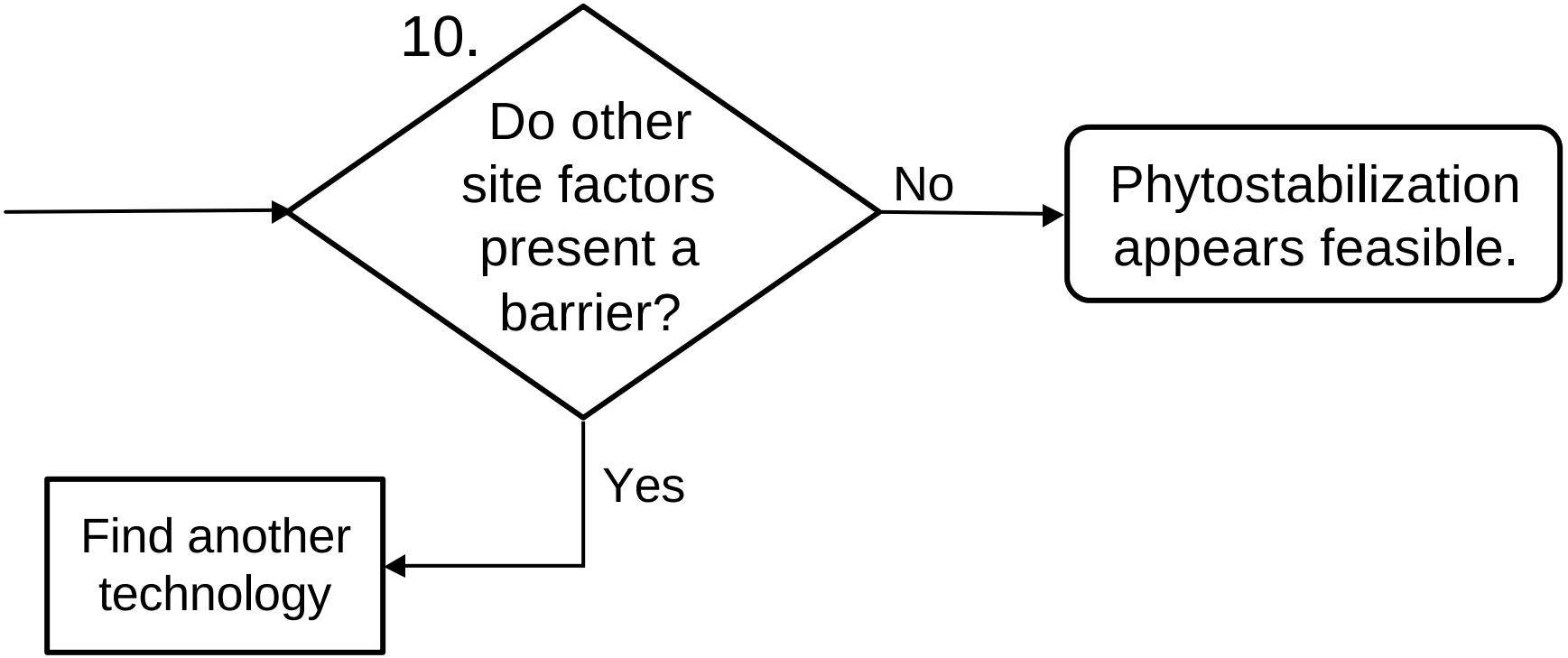
Technical Screening - continued



Technical Screening - continued

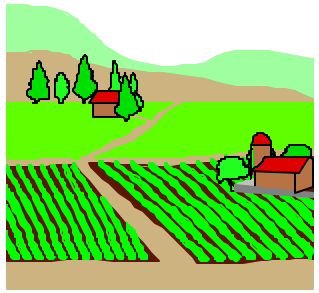


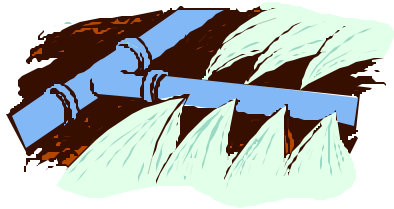
Technical Screening - concluded



Implementation

- Select plants suited to site conditions
- Verify site data and PET estimates
- Design the planting layout
- Prepare the soil to promote root growth
- Add soil amendments
- Install irrigation system

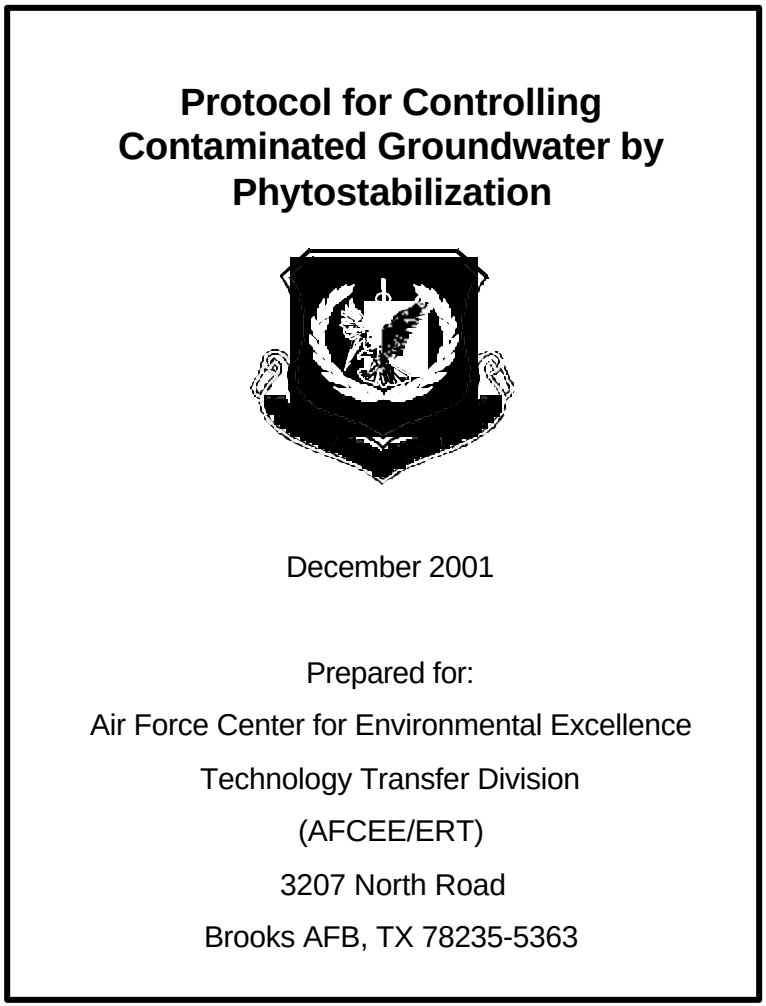




Guidance Documents

- ***Protocol for Controlling Contaminated Groundwater by Phytostabilization (December 2001)***
  - **Located in AFCEE Website**
    http://www.afcee.brooks.af.mil

- ***Phytotechnology Technical and Regulatory Guidance Document (April 2001)***
  - **Located at ITRC Website**
    http://www.itrcweb.org



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Prepared for:

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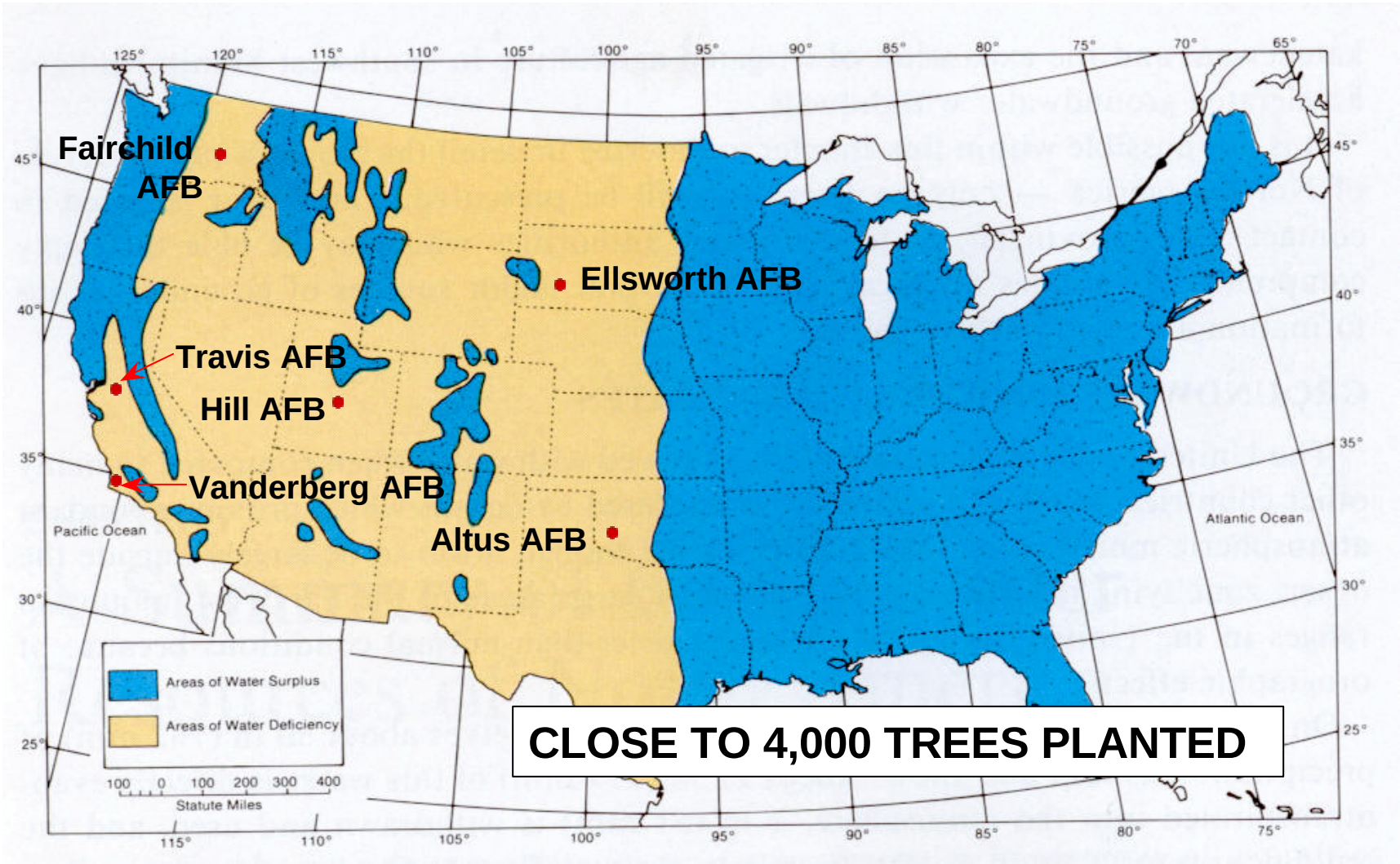
(AFCEE/ERT)

3207 North Road

Brooks AFB, TX 78235-5363

AFCEE Demonstration Sites



Questions

THANK-YOU